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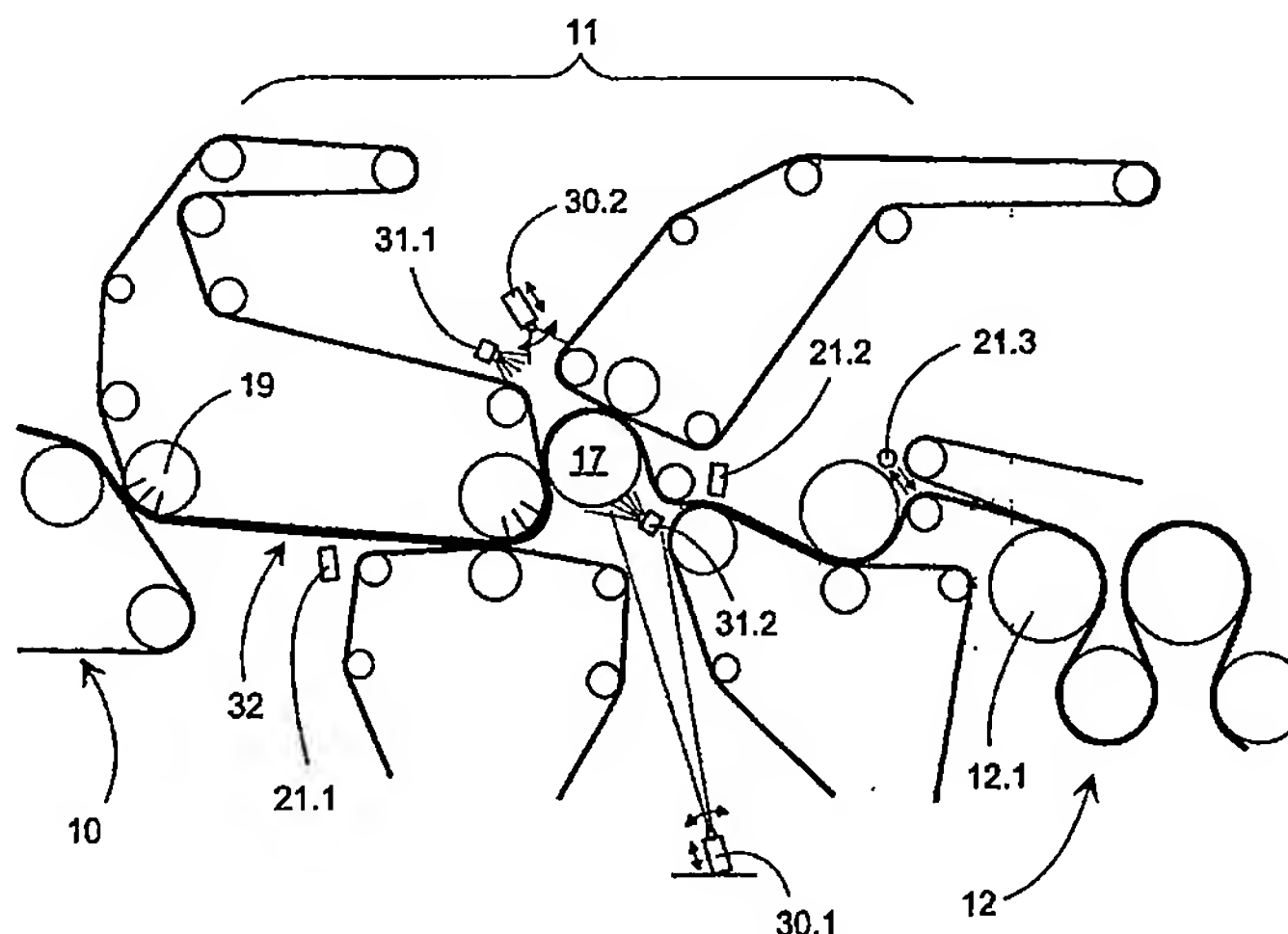
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(54) Title: METHOD AND SYSTEM FOR MAINTAINING RUNNABILITY IN A PAPER OR BOARD MACHINE



(57) Abstract: The invention concerns a method and system for maintaining runnability in a paper or board machine, which machine for making paper or board includes two or more successive section complexes, such as a web formation section (10), a press section (11), a drying section (12) and a finishing device (13), and wherein at the section complex (10 - 13) (i) cleaning measures are carried out, (ii) the cleanness level is checked, (iii) if the cleanness level does not meet the criteria established for it, the procedure continues from step (i), otherwise, (iv) the cleanness level is accepted. Checking of the cleanness level is performed by using computer vision and the observations obtained by computer vision are compared with a criterion value established to correspond with the required cleanness level, and based on this value the procedure either continues with cleaning measures (i) or the cleanness level is accepted (iv).

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METHOD AND SYSTEM FOR MAINTAINING RUNNABILITY IN A PAPER OR BOARD MACHINE

The invention concerns a method for maintaining runnability in
5 a paper or board machine, wherein the machine for making paper
or board includes two or more successive section complexes,
such as a web formation section, a press section, a drying
section and a finishing device, and wherein in connection with
a break the following takes place at the section complex

- 10 (i) cleaning measures are carried out,
- (ii) the cleanness level is checked,
- (iii) if the cleanness level does not meet the criteria established for it, the procedure is continued from step (i), otherwise,
- 15 (iv) the cleanness level is accepted.

In addition, the invention also concerns a corresponding system.

Nowadays, the running speeds of paper and board machines, both
20 of which are referred to hereinafter as paper machine as a
common name, have increased and become high from the viewpoint,
among others, of web management. The runnability of the paper
machine plays a significant role as regards the machine's
productivity. Although attempts have been made in many differ-
25 ent ways to develop runnability, web breaks occur from time to
time in the paper machine.

The restarting of production associated with break situations
often requires, for example, cleaning measures at the breaking
30 point. Cleaning may also be carried out as the production goes
on in applicable parts. In the section complex where the break
occurs and in the machine's following section complexes a tail
threading procedure is carried out after cleaning. Other
situations where breaking easily may occur or generally such

where the said tail threading procedure is also carried out, are, for example, starting after shutdown of the machine and possibly also grade changes.

5 Such critical positions where web breaks may occur are in the wet end of the machine, for example, in the press section. Furthermore, break situations may equally occur in the drying section, at coating stations (1st and 2nd station), if such are used, and at the reeler, especially during the reeling drum
10 change. In the actual break situation time may be wasted even to find out the exact place of the break. Such unclear breaking places may be located, for example, in the border regions of the press section and drying section and also in the border regions of the breaker stack and the coating station.

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Development of tail threading and of the related equipment, facilitation of cleaning during the break and improvement of the reliability of break monitoring equipment are factors, among others, which play important roles in reducing the break
20 time.

In the state of the art, the tail threading procedure is nowadays performed either entirely manually or, for example, with the aid of blowing, whereby the machine operator also
25 attends to the carrying out of this measure. Furthermore, various kinds of leader or tail end conveyors, disk sets and pulley sets may be used in the tail threading. The paper machine operator is also the person mainly attending to their control and adjustment, for example, from the control desk.

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The state-of-the-art start-up of production and the tail threading procedure to be performed as one step therein require changing of equipment adjustments and of process conditions to a level needed for successful tail threading or production. The

adjustments and changes in question are also made manually, almost without exception, by the machine operator using the switches on the control desk.

5 Especially in connection with break situations cleaning is needed in the paper machine in order to remove machine broke resulting from the break Nowadays the machine operating staff does the cleaning manually. Depending on the section complex or the position to be cleaned, this is done, for example, by
10 blowing air or by washing, wherein the broke is removed from the machine structures. The staff supplies the blowing air and directs it to the object to be cleaned, for example, using a hose, which is difficult and even dangerous to move beside a machine in operation.

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During the cleaning work the paper machine's moving components, such as, for example, rolls and cylinders, are usually kept in rotation, because stopping them entirely would delay excessively the start-up of production. Hereby the risk exists, for
20 example, that the person doing the cleaning measures may lose his balance while working close to rotating components. Such a exemplary situation can be mentioned as another risky one, where the blowing hose carried by the cleaning person becomes entangled with a moving component. Consequences are usually
25 fatal in both these cases. Serious safety risks thus occur in this cleaning work near moving components, for which reason strict safety provisions have been laid down for this work, which provisions are difficult to comply with, especially given the present-day working methods.

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Furthermore, besides the structures to be cleaned in the machine hall, there are various kinds of beam structures, for example, at basement level, where paper chaff will gather with time. The structures on the basement level are also difficult

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to reach for cleaning purposes. Paper shreds collecting on beams even constitute a fire risk in a certain sense. In addition, when carried along by airflows they may find their way to the web area and cause a web break there.

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Despite the operating routines possibly acquired by the paper machine operator over several service years, the risk of human error always exists in the tail threading procedure. This risk will occur, for example, when the operator gets distracted, if
10 even for a moment. Furthermore, the manual tail threading procedure, which has become an instinctive routine with the operator by being repeated times without number, may take place time and time again according to a habitual non-optimum model of operation, to which the operator has become used over the
15 years based on human experiences. In these days, despite the paper machine's control system being programmed to a high degree, the operator must be aware of several machine running parameters, especially in the tail threading stage, concerning its progress and he must also make decisions to adjust them in
20 order to perform the tail threading procedure successfully.

It is a purpose of this invention to bring about a method for maintaining the runnability of a paper or board machine. The characteristic features of the invention are presented in claim
25 1. The invention also concerns a corresponding system, the characteristic features of which are presented in claim 13.

In the method and system according to the invention, the machine's state of cleanness is monitored by utilising computer
30 vision. In this way an essentially more effective, safer and more rational cleaning of the machine is achieved than with the working methods known today. In particular, the method and system according to the invention may be applied in connection with break situations.

Furthermore, according to one embodiment of the invention, in the method according to the invention it is possible to carry out in selected parts or even entirely the functions relating to maintenance of machine runnability and web management, such as, for example, the steps relating to cleaning, the tail threading procedure and start-up of production, in a manner independent of the operator's actions as a sequence of events automated in the machine's control system.

10 Computer vision technology is utilised in the method according to the invention. Furthermore, characteristic values or other web identifiers relayed by the machine's measuring system may be utilised to detect if the web is on and to determine threading tail characteristics in order to achieve a successful
15 start-up of the production.

The method and system according to the invention may be applied advantageously even generally in cleaning operations to be carried out in the various steps of the paper machine. Detection of the cleanness level of machine structures and components may be arranged with detection means to take place from several different directions and in certain positions, even from inside the structures. This gives confidence in ascertaining and confirming the cleanness level of areas, which are
25 critical for the complicated machine structures and for breaks.

According to one embodiment, the measures relating to cleaning may be integrated in the machine's control system and also in the start-up of production. Artificial intelligence may be
30 associated with the control system, whereby it may be arranged as a so-called "learning system". Of the observations to do with the cleanness level, cleaning and tail threading, information may also be formed for carrying out the condition monitoring. The information may then be relayed to a special remote

monitoring functionality for analysis and for diagnosing problematic positions.

With the method and system according to the invention a significantly improved safety level of the paper machine is achieved and the established safety provisions are fulfilled in order to ensure industrial safety for the machine operating staff. Furthermore, the machine's production capacity is improved significantly compared with the known capacity. The automation of cleaning measures and the start of the tail threading procedure in the machine's control system in selected parts or entirely eliminates failed tail threading and production losses resulting from human errors of the machine operator, from work torpor and any manners of performing the tail threading procedure in a disadvantageous manner. Other additional advantages made possible by the method and system according to the invention will emerge from the description part, while the characteristic features will emerge from the appended claims.

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The method and system according to the invention, which are not limited to the embodiment presented in the following, will be described in greater detail by referring to the appended figures, wherein

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Figure 1 is a schematic view of a paper machine shown as an example,

Figure 2 shows an example according to the invention of the press section of a paper machine,

30 Figure 3 shows an example according to the invention of the drying section of a paper machine,

Figure 4a shows an example according to the invention of the area in between a paper machine's drying section and reeler,

- Figure 4b is a view of Figure 4a seen from above,
Figure 5a shows an example of the cleaning equipment for a paper machine's beam structures seen from the side,
5 Figure 5b is a cross-sectional view of Figure 5a,
Figure 6a shows another example of the cleaning equipment for a paper machine's beam structures seen from the side,
Figure 6b is a cross-sectional view of Figure 6a, and
10 Figure 7 is a flow diagram of the method according to the invention.

The rough schematic view in Figure 1 shows a paper machine. The machine is formed by section complexes, which are the web
15 formation section 10, the press section 11, the multi-step drying section 12 and the finishing device 13. In the case shown as an example, the finishing device is a reeler 13. The finishing device 13 may also be a coating device, a calender or an after-drying section following after these or, for example,
20 a combination of some of the above (for example, a machine calender-reeler).

The method and system according to the invention can be advantageously applied in every section complex of the paper
25 machine. Further, in every section complex the method can be applied in several different breakpoints. In the following, the method according to the invention will be described first in connection with start-up of the press section 11 to be performed in consequence of a web break occurring in press section
30 11 and in the following start-up of the drying section 12, and further in the taking up of the web on to reeler 13. It should be noticed that the method and system according to the invention for maintaining runnability are in no way limited, for

example, to any web break situation context, but they may also be used in applicable parts with ongoing production.

Figure 2 shows an example of the press section 11 of a paper machine. In a production run of the machine, a web break may occur in the press section 11, caused, for example, by entanglement of the paper web 32 with a central roll 17. In the web break situation, the tail of the paper web 32 will travel directly either on to reeler 13 or alternatively it will break into one or more parts at the machine's section complexes 11 - 13 following after the first breakpoint proper. Hereby paper shreds may occur in the section complexes in several different positions, which will, for example, make it difficult to perform the following tail threading or will cause other harmful effects.

According to an advantageous embodiment, detection of the break and a closer clarification of the breakpoint take place by utilising the machine's measuring or sensor systems. A first example of a sensor for use in finding the breakpoint at the press section 11 and already existing in the machine could be detection of whether the web 32 is on with the aid of photocells 21.1, 21.2. Photocells 21.1, 21.2 may be located in various positions at the press section 11 and generally at the different section complexes 10 - 13 of the machine. However, certain uncertainty factors are related to detection based on photocells 21.1, 21.2. It may give false information about whether the web 32 is on, for example, in such a case where loose paper shreds have gathered into its area of detection.

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In another advantageous embodiment, to detect whether the web is on, detection based on reflection of a light ray sent against the web 32 may be used (PosiEye). When the web 32 is on, it will reflect with a certain intensity the light ray sent by

a sensor 21.3. The intensity of a light ray reflected from the paper web 32 is essentially higher than the intensity of such a light ray reflected from machine structures or from wires, which is received by sensor 21.3 in case web 32 is not on.

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According to a third advantageous embodiment, it is possible to detect, for example, the web's 32 tension values in different measuring positions. An example is the measuring information or tension measurement to be conducted through the paper web's 32 cross-sectional profile's measuring device 23 (Figures 1 and 4a) located in the area 25 between drying section 12 and reeler 13. At the tension measurement points or such following after the breakpoint in the measurement, a steep reduction of the web tension, for example, is detected in a web break situation. Also at the tension measurement points before the breakpoint it is possible to detect maintained tension or also its steep reduction, depending on the breakpoint in the machine direction. Other detection devices or measurement values may also be used in order to determine whether the web 32 is on and to localize the breakpoint more exactly.

Based on the change reported by the chosen detection or measuring device, the web monitoring automation of the machine concludes the occurrence of a web break and localizes it in a certain section complex 10 - 13 and therein possibly within a certain section interval according to the measuring device or sensor individualizing the break.

When a break occurs in press section 11, the pick-up roll 19 will rise upwards and the web 32 running from wire section 10 is guided from the border of wire section 10 and press section 11 into a pulper (not shown). A signal indicating the break situation is relayed to a cleaning system located within the area of press section 11, which cleaning system includes one or

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more purposefully located cleaning jets 31.1, 31.2. These are used to perform cleaning measures in order to clean section complex 11 for the tail-threading step (i, Figure 7). The cleaning measures can be started automatically after the break 5 is detected or the operator may also start them with a separate command.

Simultaneously, using one or more purposefully located detection means, which may be optical filming devices, such as, for 10 example, digital cameras 30.1, 30.2, located at press section 11, filming (ii) is started of the localized break area or generally of the section complex 11. Cameras 30.1, 30.2 are arranged as required at the different section complexes 10 - 13 of the machine in such a way that they will provide sufficient 15 wide-ranging information, especially on areas susceptible to breaking, however, not excluding other areas. Furthermore, the cameras 30.1, 30.2 may be arranged not in a fixed mounting but in frameworks located in the cross machine direction in such a way that they are traversing or so that they rotate unrestrict- 20 edly in their holders (not shown).

According to an exemplary embodiment, the visual information provided by the cameras 30.1, 30.2 may be digitalized in a manner known as such, so that the visual information is 25 converted (unless already converted) into grey scale pictures, wherein the grey scale values are scaled, for example, in 256 parts. A threshold value is set for the grey scale values, whereby values under the threshold value, that is, the lighter areas, are interpreted as paper or other impurities, whereas 30 the darker areas are interpreted as machine structures. A so-called zero image may be stored of the clean machine structures from each filming position, which zero image is free of paper waste or other such impurities. The digitalized grey scale images relayed by the cameras 30.1, 30.2 are compared with

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these zero images, and based on these the cleanness level of the section complex 11 is ascertained, that is, conclusions are drawn as regards the positions in need of cleaning.

5 In its simplest form, depending on the lack of light tones in machine structures and in the environment of filming positions, the visual information on the break situation may be sufficient as relayed by cameras 30.1, 30.2 without any so-called zero image. Other ways of interpreting the visual information and of
10 pattern recognition generally are of course also possible. Such are, for example, changes emerging in successive images or generally the limit values set for grey tones.

In the method and system according to the invention, the press
15 section's 11 cleaning equipment is thus formed by different water and air jets 31.1, 31.2. The jets 31.1, 31.2 are located in known areas, which are critical as regards breaks, and they may be movable and targetable to their cleaning target. According to an advantageous embodiment, the directing of the
20 cleaning system's jets 31.1, 31.2 is connected to the camera system's 30.1, 30.2 alignments or generally to the information it produces, whereby the alignment of jets 31.1, 31.2 may be set in the machine cross direction based on the places of cameras 30.1, 30.2, their filming angles or generally on the
25 visual information they produce. The cameras 30.1, 30.2 and jets 31.1, 31.2 may also be remote controlled.

After the performed cleaning measures (i), the camera system is used to check the cleanness level (ii) of the section complex
30 11. In case the cleanness level fails to meet the criteria (iii) established for it, the cleaning measures are continued, for example, in such a way that the position and direction of jets 31.1, 31.2 are changed in order to achieve the desired result (i). One example of such a criterion may be the section

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complex's share of light tones or the grey tone analysis mentioned above.

When the section complex's 11 cleanness level is acceptable
5 (iv), a command may be given to the web management system to start the web's 32 tail threading procedure (v - vii). Thus, the acceptance of the cleanness level (iv) triggers the tail threading procedure to start. Triggering may be carried out in the machine control system 50 in an essentially automated
10 manner or, alternatively, it may be done by the machine operating staff with a separate command. Cleaning and tail threading starting commands (i, v, vi) may be given from the machine control room or through a remote connection 52 in connection with the control system 50 (Figure 3). In addition,
15 also the check of the cleanness level (ii) may be carried out by using remote control 52. Hereby the press section's 11 pick-up roll 19 is lowered and the web 32 is taken on to the central roll 17 or, depending on the machine type, the web 32 may also be guided directly to the drying section's 12 first drying
20 cylinder 12.1.

Simultaneously, when the cleaning measures (i - iv) according to the method of the invention have been carried out at the press section 11 as well as the following tail threading
25 measures (v - vii), the drying section 12 and the following finishing device 13 are preferably prepared also for the tail threading procedure. With the corresponding purposefully located camera and cleaning equipment presented at the press section 11 cleaning has been carried out of the drying section
30 12 and the finishing section, that is, in this example the reeler 13, and the cleanness level of the section complexes 12, 13 has been checked and found to be of a level required for a successful tail threading procedure.

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Figure 3 shows in drying section 12 one drying group 12' implementing the method according to the invention. Monitoring sensors 21.4, 21.5 detecting if the web is on are located at the drying section 12 in between vacuum rolls 18, which sensors 5 may also be based on measurement of the light reflection intensity (PosiEye), in accordance with the principle presented above. Furthermore, drying section 12 includes, for example, under the machine structures movable and targetable cameras 30.3, 30.4 and cleaning jets 31.3, which are air jets as far as 10 the drying section 12 is concerned. The air jets 31.3 are arranged in such a way that they can be used to blow into the basement loose paper waste and such which is doctored off the drying cylinders 16 by doctor blades 37. In applicable positions the detection and cleaning means may also be located in 15 between machine structures and they can also be moved there, for example, by extension arm arrangements. The beam 60 may be one example of such a mounting located in between machine structures.

20 When the cameras 30.1, 30.2 and web identifiers 21.1, 21.2 relay information on a successful on-positioning of web 32 at press section 11, the tail threading procedure from press section 11 to drying section 12 can be started either automatically or by a separate command. The speed difference between 25 press section 11 and drying section 12 is adjusted to a suitable level and the threading tail is cut by a bias-cutter to be ready for tail threading at drying section 12 (not shown). Except the threading tail, the remaining part of web 32 is guided into the pulper (not shown). Conditions in drying 30 section 12 are controlled to be favourable for the threading of tail 39 or for production (v). Hereby the temperature of cylinders 16 may be adjusted, among other things. This preparation step may be done either after the cleanness level accep-

tance step (iv) or even partly during the cleaning measures (i - iii).

When at the end of press section 11 the tension of the threading tail is found to be at a suitable level for a successful tail threading, guiding of the threading tail to drying section 12 is carried out in a known manner. The tail threading procedure of the drying section 12 is carried out in manners known as such (vi - vii).

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The cameras 30.3, 30.4 and other web monitoring equipment 21.4, 21.5 known as such are used to detect a successful tail threading at drying section 12, and with the machine concepts of today this is usually done in one step (vi). When threading tail 39 has been guided successfully to the end of drying section 12, the web 32 can be spread out automatically to its whole width by a bias-cutting device (not shown) arranged at the border of press section 11 and drying section 12 (vii). In case a web break occurs at drying section 12, the web 32 is guided from the breakpoint or from the preceding border point of drying groups into the basement and further into the pulper (not shown).

Figure 4a shows the intermediate area 25 in between drying section 12 and reeler 13. This intermediate area 25 also includes cameras 30.5 - 30.7, which are located in purposefully places and which provide sufficiently covering information on the cleanness level of the area. Besides as shown in the example, cameras may also be located on the side of structures, below them or even in the middle of the structures. The cleaning jets 31.4, 31.5 are also arranged in such a way that they will produce the required cleaning result.

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When web 32 has been successfully spread out to its full width to the end of drying section 12 and the cleanness level of the intermediate area 25 and of the reeler 13 is at an acceptable level after one or more iteration cycles (i - iii), the
5 threading tail is cut for tail threading at reeler 13. Cutting of the threading tail is preferably performed, for example, in the middle of the web 32 using a double bias-cutter 14 (DoubleJet). Cutter 14 is located, for example, against the last-but-one vacuum roll 18' in such a way that its jets will
10 cut the threading tail against the drying wire and the vacuum roll 18' located below it.

Immediately after the cutting, the threading tail 39 is guided through the intermediate area 25 in between drying section 12
15 and reeler 13 (vi). In the intermediate area 25, the threading ~~tail 39 and later the web 32 are supported on leading rolls 22,~~ 24, 27, 38, among other things. Guiding takes place, for example, by using tail threading devices using vacuum, blowing or their combinations. In the concept shown as an example, tail
20 threading device 33.1 - 33.6 (FoilForcel) based on vacuum is used, of which six are arranged in the intermediate area 25 between drying section 12 and reeler 13 in all open intervals. It is also possible to use other kinds of threading tail cutting and tail threading techniques. Reference number 26
25 indicates a steam box, which is used to control a good cross-sectional humidity profile for the web 32.

Figure 4b shows an image formed of the information relayed by the cameras 30.5 - 30.7 and showing the intermediate area 25
30 between drying section 12 and reeler 13, which corresponds with the concept shown in Figure 4a seen from above. In the figure spreading of the web 32 is under way (the cross-lined area) using device 14 from threading tail 39 to production width (vii). As a rule, the spreading step is carried out automati-

cally. The figure shows an example, where the cleanness level of the area 25 can be checked, and based on this cleaning measures can be performed with jets 31.4, 31.5. Any paper shreds adhering to structures would be seen in the image in a similar way as the web 32 and threading tail 39 now shown therein.

Reeling drum exchanges in reeler 13, possible speed difference settings and wetting during tail threading and spreading of the web may also be automated in the control system of the machine.

When the reeler 13 has been used to perform also the said preliminary measures, tail threading is begun from drying section 12 to reeler 13. Success of the tail threading procedure is detected with the aid of the computer vision/camera system arranged purposefully in the described manner. The tension of the successful threading tail 39 is recognized, for example, by tension measurement (for example, IQ-tension) located in the area between drying section 12 and reeler 13 or by a measurement based on weighing (these are not shown) and the humidity is recognized by temperature measurement 15. The tension value of threading tail 39 and the temperature measurement 15, which thus correlates with the humidity level of threading tail, set a criterion condition for an automatic spreading out of web 32 to its full width.

When the web has been spread out to the down-taking point of reeler 13, the sequence of events arranged to be automatic can continue by taking on to reeler 13, where the web 32 in its full width is blown on to the empty reeling drum 34. After this the paper machine is in production run (viii).

As one more example of very difficult places to be cleaned the static crossbeam structures 54 can be mentioned, which are

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located in the basement 53 of the machine. These may cover the interval wholly or in part from the machine's edge on the service side 57 to the edge on the operation side. It is true though, that such beam structures 54 may exist also elsewhere in connection with the machine and not only at basement level 53.

Figures 5a - 6b show two different embodiments for keeping this kind of beam structures 54 clean. In the embodiment shown in Figures 5a and 5b, a stringer 55 is arranged on top of beam 55, which stringer includes a channel rail fit. In channel 61 one or more blades 56 are arranged or other such parts moving back and forth in the machine cross direction to cut and generally to remove from atop beam 55 the paper shreds collected on the stringer 55. If there are several blades 56, they may move, for example, crosswise on stringer 55.

The stringer 55 may preferably be somewhat rounded off on its side at the blade side, which makes it easier for the paper shreds cut or shredded by blades 54 to drop down into the basement premises 53. The guide beam 55 may have quite a light structure and the electric motors suitable for moving the blades 56 may have quite a low power in order to perform the cleaning measures successfully.

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Figures 6a and 6b show one more embodiment for keeping the beam structures 54 clean. Here the beam structure 54 is surrounded by a wire link 58, which travels through bending rolls 59 placed on both sides of beam 54, whereby one of the bending rolls is arranged to be driven. Although in this embodiment the bending rolls 59 are above and below beam 54, they may of course be located also in other arrangements, depending partly, for example, on the dimensions of beam 54. Paper shreds collected on the wire 58 can be removed and dropped further

down to basement level 53 by running the wire link 58, for example, back and forth. The use of cleaning equipment may be connected with the machine's control system 50 through a data transmission bus (BUS) and it may be automated to take place, 5 for example, at regular intervals. It is possible also in this case to apply computer vision technology.

As is shown in Figure 3, it is possible according to an advantageous embodiment to connect also artificial intelligence 10 to the cleaning system integrated with the machine's control system 50, whereby it may be arranged as a so-called "learning system". Hereby, besides the fact that the automatic system can pay attention to possible known problematic areas, it also registers and stores new problematic points occurring in a 15 break situation as well as such which occur frequently, and it ~~will take these into account in following break situations.~~ Examples of problematic points are those, which are difficult in terms of tail threading and cleaning. The information can be utilised, for example, in looking for the breakpoint and in 20 directing the cleaning jets precisely to these learned problematic points.

The method according to the invention can also be advantageously utilised as a part of preventive condition monitoring 25 and maintenance. In preventive condition monitoring, information can be formed of obtained detections concerning the machine, which information is relayed through data communication network 51 to a special remote server 52. In connection with remote server 52 there is a functionality, which analyses 30 the received information by chosen criteria. Examples of such criteria could be the cleaning result and various time responses relating to the cleaning and/or tail threading functions or steps. If the duration of tail threading attempts or of break situations in general exceeds the established limit

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value, a preliminary alarm may be given at the machine, possibly not until the flare-up phase, or of an already existing problematic situation of which the machine operator is not aware. The functionality may further include a special
5 diagnostics partition, which from the received information diagnoses the reasons for the occurring problem.

Furthermore, in such an alarm situation a service team may be sent to the paper machine as well as a possible spare parts
10 dispatch in order to put right an occurring problem or one already existing. The machine operating staff may also be informed about the problem and given instructions for dealing with it. In addition, remote adjustment of equipment based on the information is also possible, which may include, for
15 example, directing of the detection and cleaning equipment and ~~changing of paths of motion and generally, for example,~~
adjustment of the equipment affecting tail threading or even starting and performance of the actual tail threading procedure.

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The section complex 10 - 13 may also be illuminated with ultra violet light at least during the cleanness level check and the inspection. This makes it easier to distinguish paper shreds from the machine structures, because it makes many paper grades
25 "glow" in a manner of speaking (not shown).

What is essential in the method according to the invention is that the cleaning measures, the cleanness level check and the acceptance of the cleanness level are performed by utilising
30 computer vision. Starting of the cleaning procedure and the following tail threading procedure may be done automatically or, alternatively, the operator may attend to starting. It should also be noticed that the location of cameras and jets shown in the figures is only rough and given by way of example.

It must be understood that the above description and the figures relating to it are only intended to illustrate the present method according to the invention. Thus, the invention is not limited only to the embodiments presented above or to
5 those defined in the claims, but many such different variations and modifications of the invention will be obvious to the man skilled in the art, which are possible within the scope of the inventive idea defined in the appended claims.

CLAIMS

1. Method for maintaining runnability in a paper or board machine, which machine for making paper or board includes two or more successive section complexes, such as a web formation section (10), a press section (11), a drying section (12) and a finishing device (13), and where at the section complex (10 - 13)

- (i) cleaning measures are carried out,
- 10 (ii) the cleanness level is checked,
- (iii) if the cleanness level does not meet the criteria established for it, the procedure continues from step (i), otherwise,
- (iv) the cleanness level is accepted,

15 characterized in that checking of the cleanness level is performed by using computer vision and wherein the observations obtained by computer vision are compared with a criterion value set up to correspond with the required cleanness level, and based on this value the procedure either continues with
20 cleaning measures (i) or the cleanness level is accepted (iv).

2. Method according to claim 1, characterized in that in connection with a break the following takes place at the section complex (10 - 13) during the cleaning steps (i - iv) or
25 after the step of acceptance of the cleanness level (iv)

- (v) advantageous conditions are established for threading of the tail (39) or for production, and
- after the step of acceptance of the cleanness level (iv),
- 30 (vi) the threading tail (39) is led in one or more steps, and
 - (vii) the threading tail (39) is spread out to form a web (32) in its full width.

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3. Method according to claim 1 or 2, characterized in that the section complex (10 - 13) includes one or more fixed and/or movable detection means, such as, for example, cameras (30.1 - 30.7).

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4. Method according to any one of claims 1 - 3, characterized in that the section complex (10 - 13) includes fixed and/or movable cleaning means (31.1 - 31.5, 56, 58, 59) for carrying out the cleaning measures.

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5. Method according to any one of claims 1 - 4, characterized in that the carrying out of cleaning measures and/or the cleanness level check and/or the step where tail threading is started (i, ii and/or iv) is carried out by using a remote
15 control functionality (52).

6. Method according to claim 2 - 5, characterized in that measuring (23) based on definition of the web tension is used in the break detection.

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7. Method according to claim 2 - 6, characterized in that optical detectors (21.1 - 21.5) are used in the break detection.

25 8. Method according to any one of claims 1 - 7, characterized in that targeting information of the detection means (30.1 - 30.7) is used in the targeting of cleaning means (31.1 - 31.5) to the target to be cleaned.

30 9. Method according to any one of claims 1 - 8, characterized in that at each section complex (10 - 13) the measures (i - v) preceding the threading (vi) of the tail (39) are carried out almost simultaneously.

10. Method according to any one of claims 1 - 9, characterized in that the machine's control system (50) is arranged to be a learning system, which stores information on the cleaning and/or tail threading events and utilises the information in
5 corresponding new cases.

11. Method according to any one of claims 1 - 10, characterized in that the section complex (10 - 13) is illuminated with ultraviolet light during the cleanness level check (ii).

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12. Method according to any one of claims 1 - 11, characterized in that information is formed of the observations in the cleaning steps (i - iv) and/or tail threading steps (v - vii) to carry out condition monitoring, which information is relayed
15 to a special remote monitoring functionality (52) for analysis.

13. System for maintaining runnability in a paper or board machine, which machine for making paper or board includes two or more successive section complexes, such as a web formation
20 section (10), a press section (11), a drying section (12) and a finishing device (13), and wherein at each section complex (10 - 13) means are fitted for maintaining runnability, characterized in that the said means include one or more detection means (30.1 - 30.7), which are arranged to monitor
25 the cleanness level of the section complex (10 - 13), and the observations made by the detection means (30.1 - 30.7) are arranged to be compared with a criterion value, which is set to correspond with the required cleanness level and based on which the cleanness level is arranged to be either rejected or
30 accepted.

14. System according to claim 13, characterized in that the means also include cleaning means (31.1 - 31.5, 56, 58, 59).

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15. System according to claim 13 or 14, characterized in that the detection means (30.1 - 30.7) are arranged to control the cleaning means (31.1 - 31.5, 56, 58, 59).

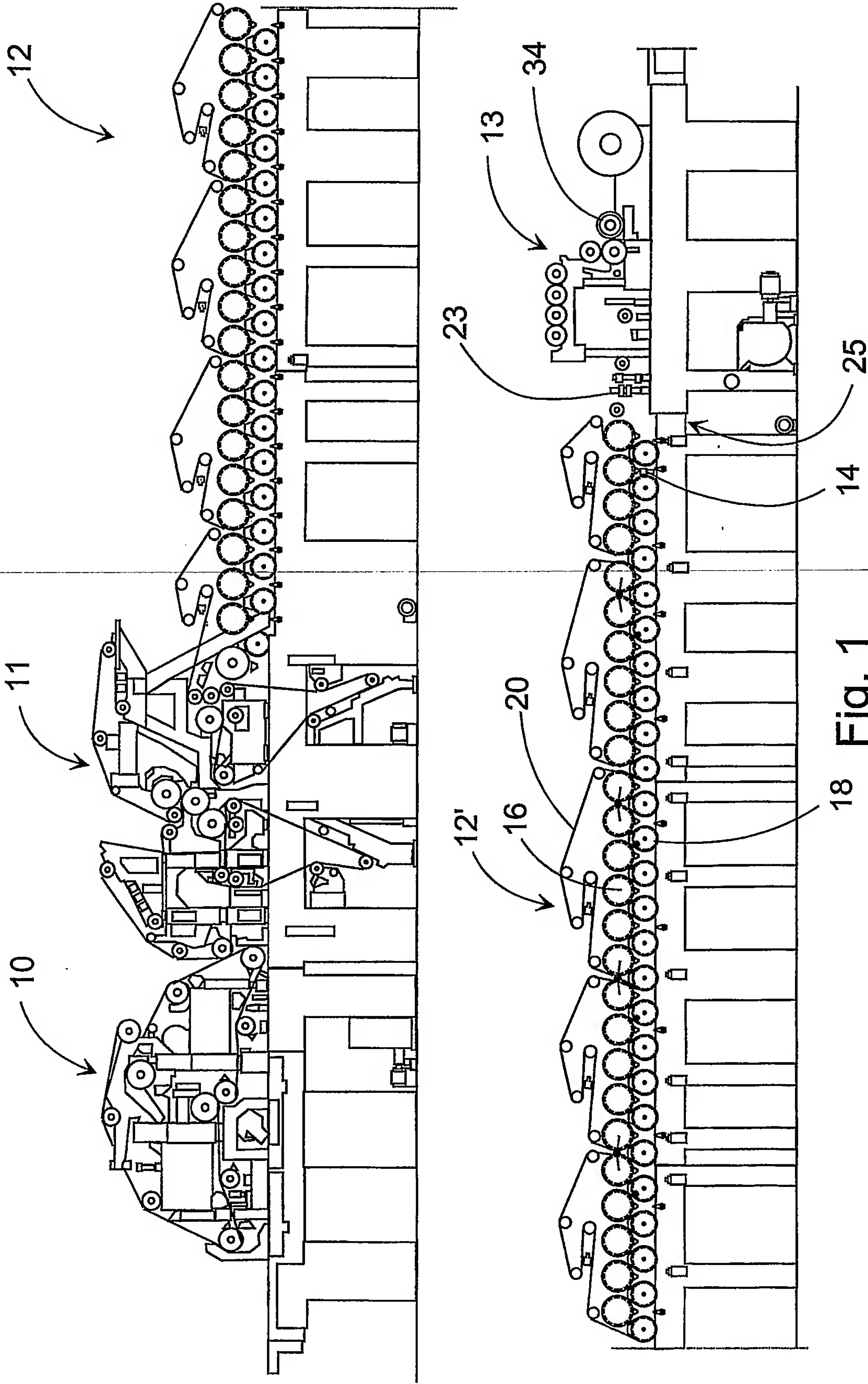


Fig. 1

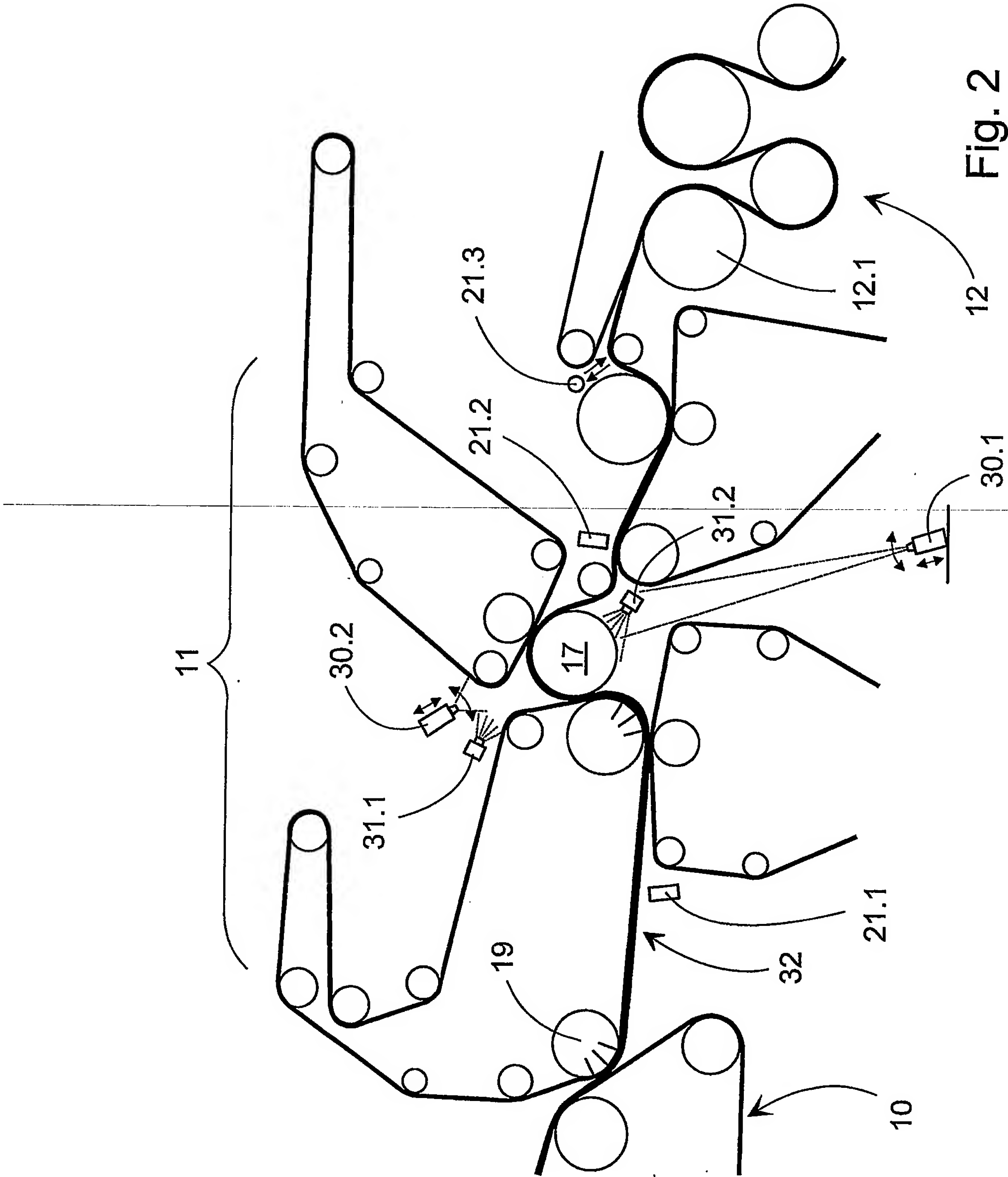


Fig. 2

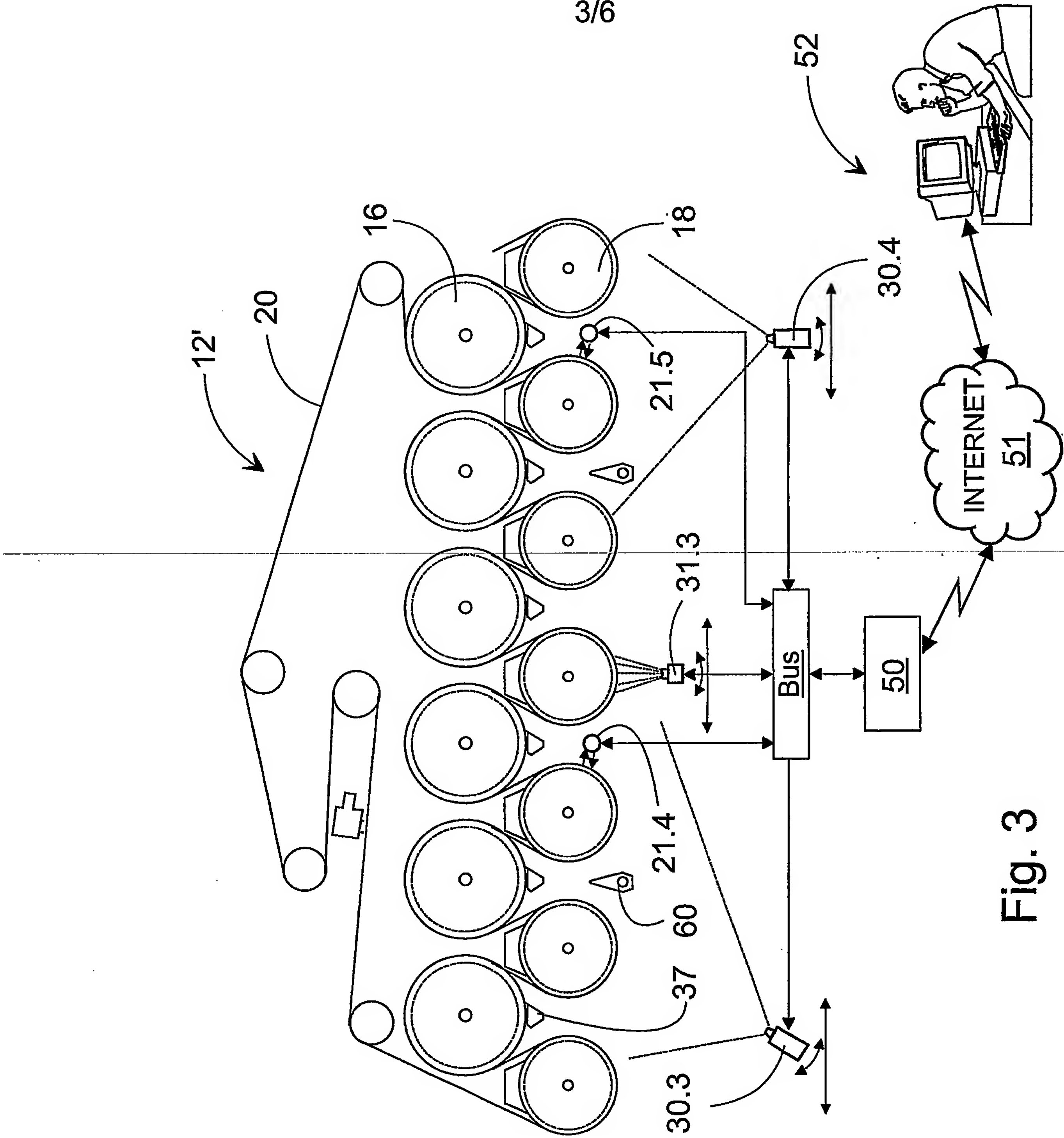
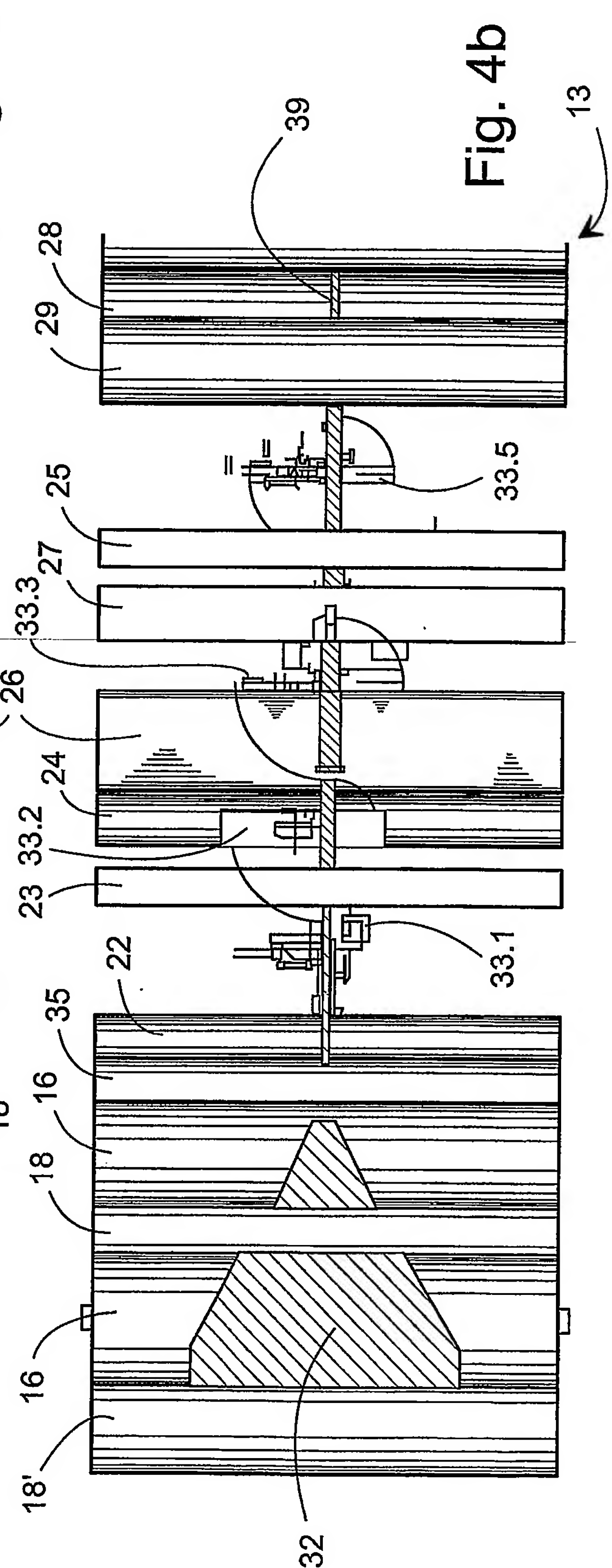
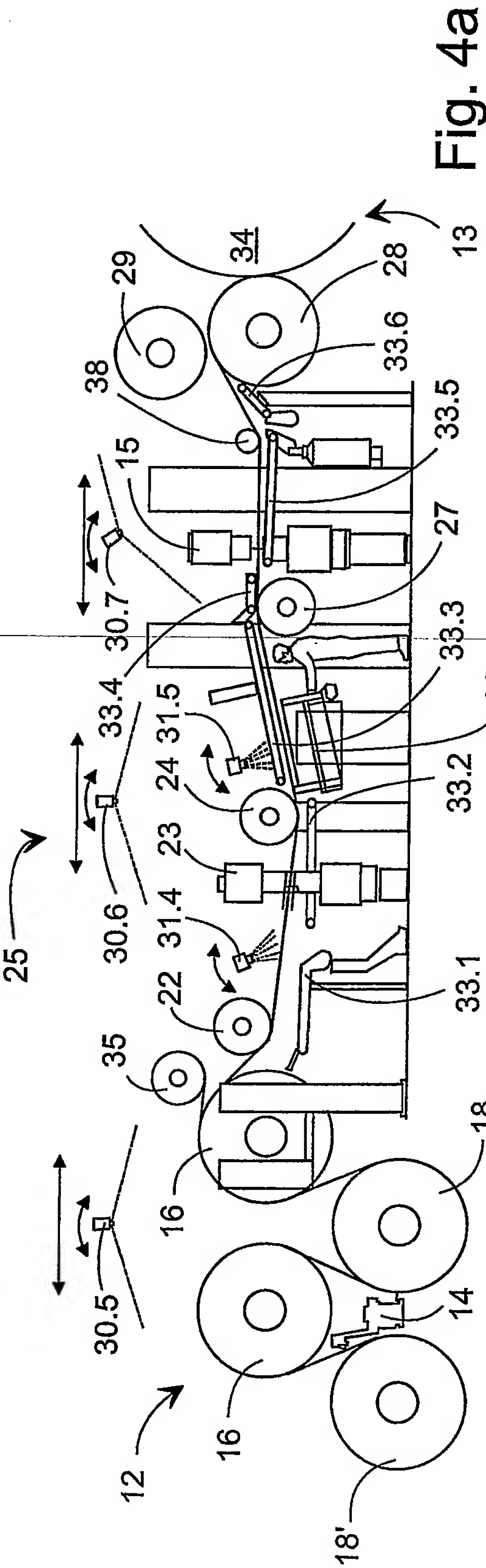


Fig. 3



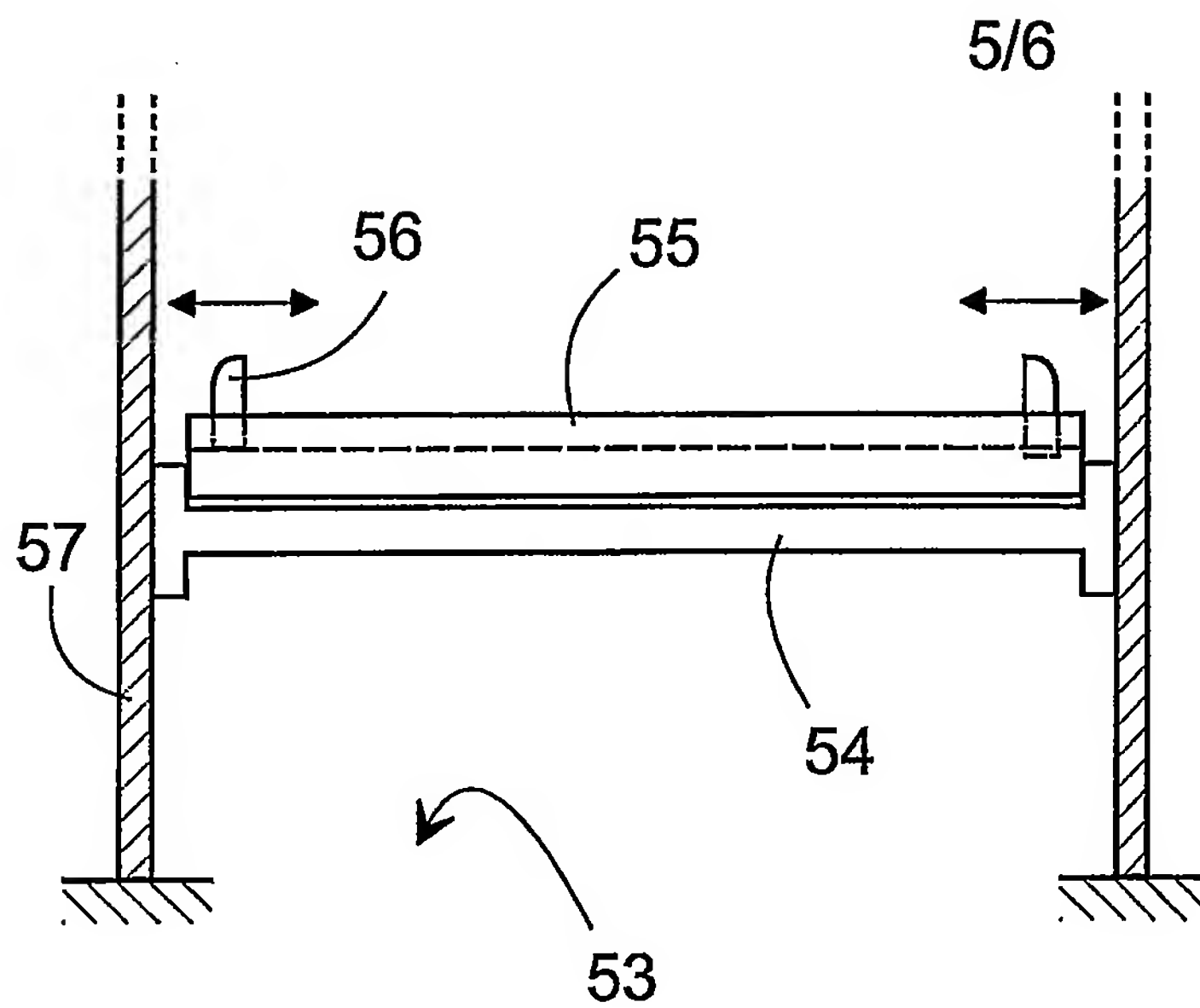


Fig. 5a

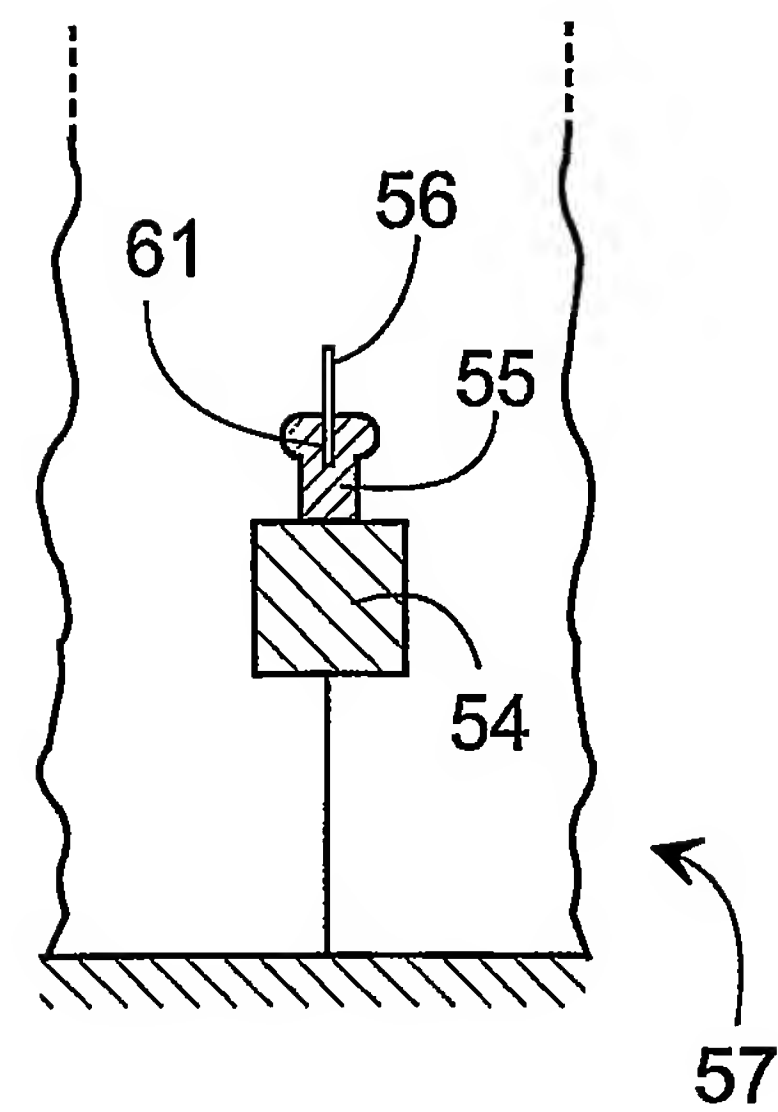


Fig. 5b

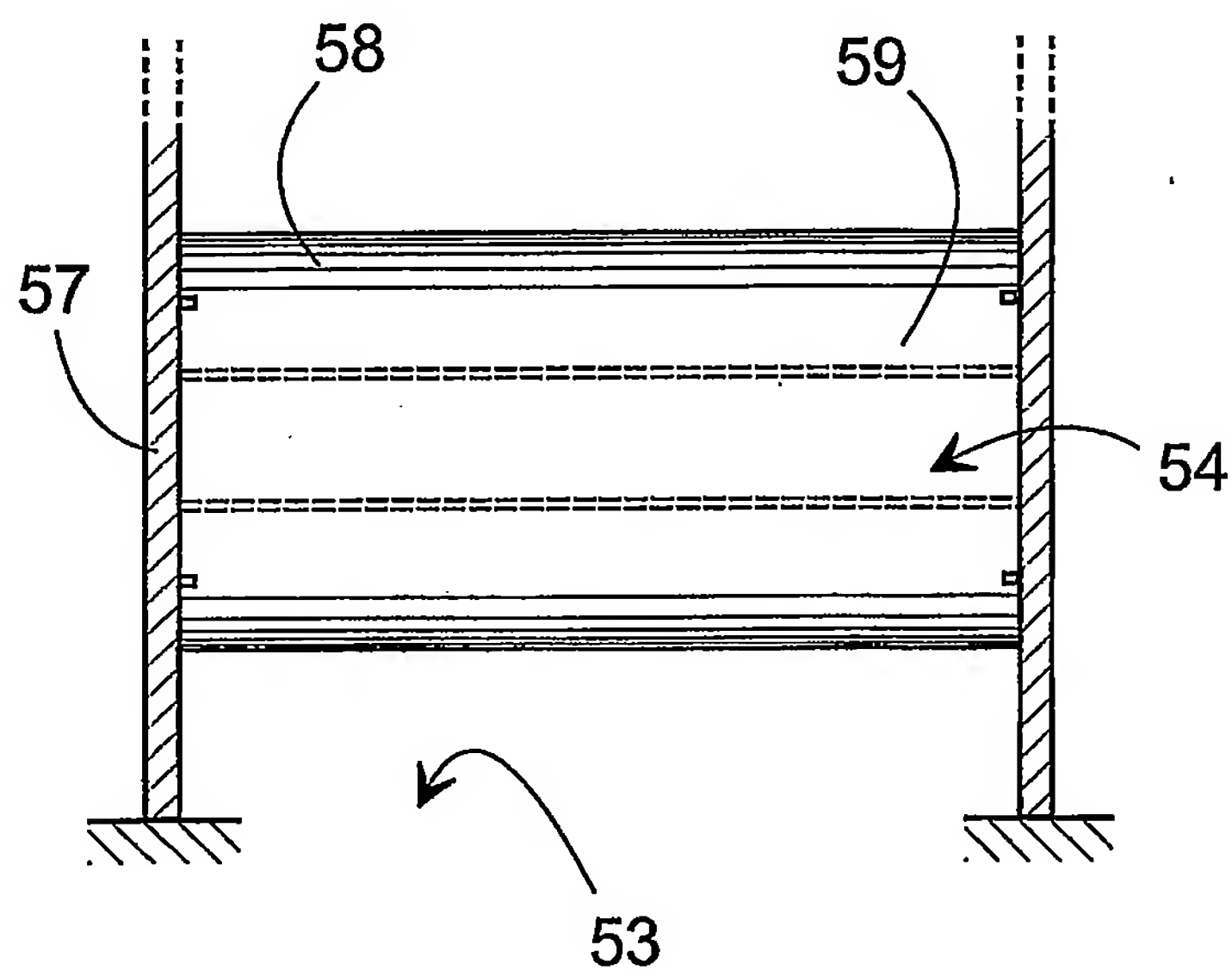


Fig. 6a

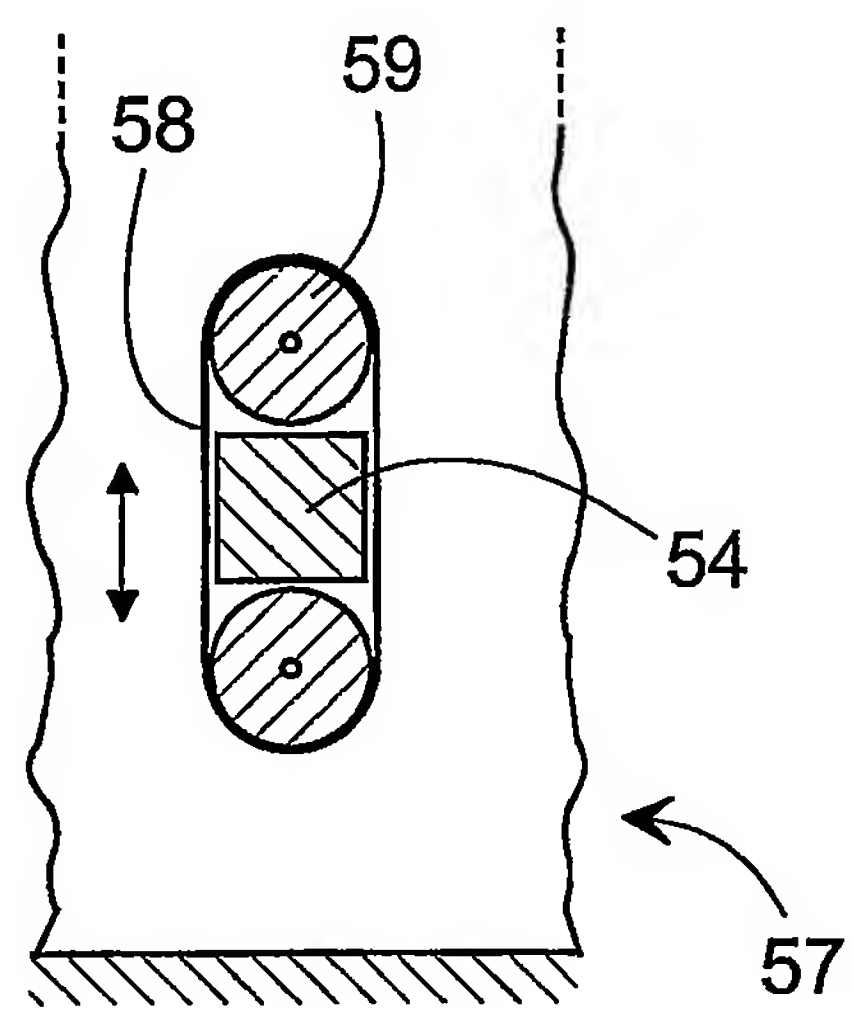


Fig. 6b

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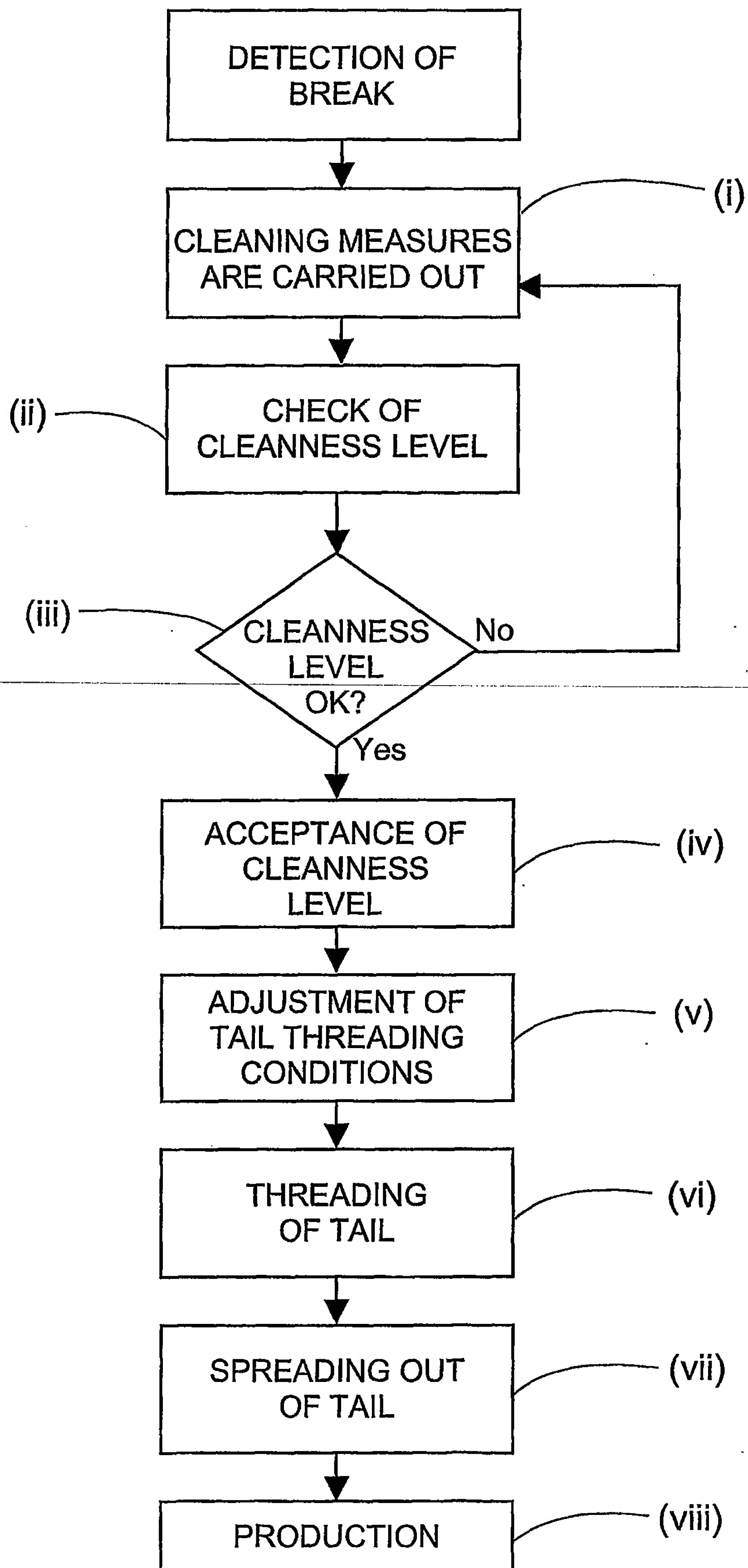


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 03/00225

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21G 9/00, G01N 21/89, D21F 7/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: D21G, G01N, D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI DATA,EPO-INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	--	6,11
Y	WO 0121888 A1 (VALMET CORPORATION), 29 March 2001 (29.03.01), abstract	6
Y	US 3535535 A (P. NASH), 20 October 1970 (20.10.70), claim 2, abstract	11
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

18 June 2003

Date of mailing of the international search report

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International application No.
PCT/FI 03/00225.

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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02/06/03

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